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Economic Liberalization and the Computer Industry: Comparing Outcomes in Brazil and Mexico

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Summary. — Market liberalization has been carried out by many developing countries in the hopes of stimulating trade, investment and technology transfer. In order to analyze the impacts of liberalization on a specific industry sector, this paper compares the experiences of Brazil and Mexico in liberalizing the computer industry in the 1990s. The authors conclude that liberalization leads to lower prices and more rapid diffusion of computer use throughout the economy, but at a cost to domestic computer firms who were harmed by foreign competition. Both countries saw an increase in computer production, but Mexico's production was mainly for export to the United States, while Brazil was producing for the domestic market. The differences between outcomes in the two countries have been determined more by environmental factors than by the nature and pace of liberalization. © 2001 Elsevier Science Ltd. All rights reserved.

Key words — Latin America, Brazil, Mexico, computer, information technology, liberalization, outcomes of liberalization

1. INTRODUCTION

Market liberalization has been embraced by most developing countries around the world since the 1980s, driven partly by neoliberal ideology and partly by pragmatism in an increasingly interconnected global economy. Developing countries who once feared economic dependency now fear being left out of the dynamic process of globalization.

The Information Technology (IT) industry has become perhaps the most globalized of all industrial sectors, especially since the growth of the personal computer (PC) industry whose horizontally specialized structure has replaced

the vertically-integrated mainframe computer industry structure (Grove, 1996). This devel-

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opment led to the growth of a global computer production network focused on East Asian countries which specialized in particular industry segments such as PC assembly, components and peripherals (Borrus, 1997; Dedrick & Kraemer, 1998; Ernst, 1994; Wong, 1995). Motivated in part by the success of these countries, newcomers such as China, India, and several others in eastern Europe and Latin America have liberalized their computer sectors in hopes of joining the global production network and gaining access to technology and capital.

This paper analyzes the liberalization process in two large developing Latin American economies—Brazil and Mexico. Both of these countries pursued protectionist policies in the computer industry during the 1980s, and both liberalized their markets in the early 1990s. While the general outlines and timing of the liberalization process are similar for the two countries, there are important differences in national environments, the pace of liberalization, and the nature of related IT policies. As a result, the outcomes and impacts of liberalization have been quite different for the two countries. This paper contrasts the two experiences and assesses the respective results.

2. THEORY, CONCEPTUAL FRAMEWORK AND METHODOLOGY

Countries around the world have been implementing economic liberalization programs in a variety of forms over the past 15 years. These have ranged from deregulation and privatization programs in developed countries such as the United States, the United Kingdom and New Zealand, to outright market reforms such as those in China and the former Soviet bloc. Latin American countries have likewise been undertaking various liberal economic reforms. The reform process was guided in many cases—Chile and Mexico in particular—by technocrats trained in the economics departments of North American universities. Their ideas on liberalization policies have thus been based on the theoretical underpinnings of neoclassical economics (e.g., Friedman & Friedman, 1980; Little, 1982), which argues that the market is the best mechanism for both allocating resources and determining investment decisions in virtually every context.

In contrast to neoclassical theory, another school of analysts have argued for a stronger

role of the state in promoting national industrial development, based on the experiences of East Asian countries (Amsden, 1989; Anchordoguy, 1989; Wade, 1990). They have credited the governments of these countries with providing domestic industries with selective protection to compete internationally while introducing limited competition to national markets. Their rationale is that simply opening up a country to international competition without a period of adjustment and without providing support to domestic producers will result in the destruction of national industries.

This paper addresses the following issues raised by the debate over liberalization:

- Is promotion of a domestic computer industry behind protective barriers a tenable strategy?
- Does liberalization lead to optimal results (in terms of output, trade, employment, technology diffusion) or are there tradeoffs between different outcomes? For example, does liberalization lead to lower prices and faster diffusion, but harm domestic producers?
- Does national environment matter or will similar policies lead to similar outcomes in different contexts?
- Can government policy intervention lead to better results than simply liberalizing and allowing market forces to work?
- What are the elements of a comprehensive policy approach to computer industry liberalization?

The analytical framework used to address these issues is presented in Figure 1, which posits that the impacts of liberalization are in fact influenced by national context, including: (a) the respective country's economic and political environment, its geographical location, its information infrastructure and national capabilities such as human resources and technology, and the structure and composition of computer production and the extent of computer use at the time of liberalization; (b) the nature of the liberalization process in question, including the timing, pace and extent of liberalization, and related IT policies, such as investment incentives, export promotion, incentives for IT use, training in IT skills and telecommunications policies.

Key outcome variables include the impact of liberalization on industry structure, computer production, trade, the domestic IT market and the nature of IT and Internet use.

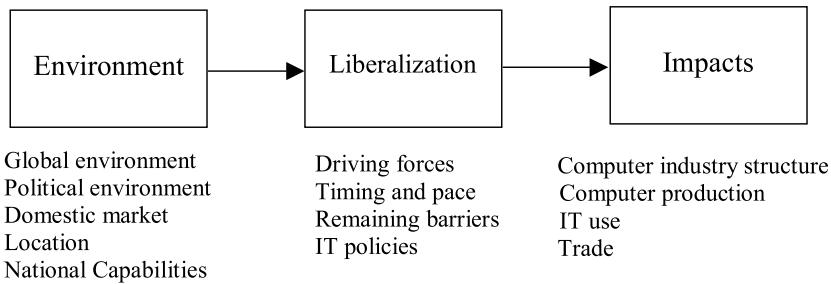


Figure 1. *Framework for comparison.*

This paper is based on research by the authors in both Mexico and Brazil, reported in several individual country papers (Botelho, Dedrick, Kraemer, & Tigre, 1999; Dedrick, Kraemer, & Palacios, 2001; Palacios, 2000; Tigre & Botelho, 2001). The primary research included extensive secondary literature reviews, and interviews with over 50 people in each country, representing the computer industry, IT user organizations, industry associations, government and academia. The authors met for two days in September 1999 to review and compare the findings of the two cases and draw conclusions as presented in the present paper.

3. ENVIRONMENT

(a) *Global environment*

The global environment influences the policies of national governments and defines the opportunities and challenges facing policy makers and business leaders. The computer industry is highly globalized, with common technology standards used around the world. This means that thousands of companies are doing research, designing and manufacturing products, and developing software for a few standard technology platforms, particularly the IBM/Wintel PC. In the face of such global economies of scale and technological dynamism, it has proven impossible to develop a competitive computer industry in an isolated national market. Examples of countries that tried and failed to develop competitive PC industries in protected markets include India and China, each of which have partially liberalized their PC markets in the 1990s (Dedrick & Kraemer, 1993; Kraemer & Dedrick, 1995). Korea protected its PC industry with a ban on imports during 1982–88, and its PC makers

have never succeeded beyond the domestic market. Japan's PC market was isolated by the adoption of technology standards incompatible with the global standard, and its PC makers have had very limited success outside Japan (West & Dedrick, 2000). By contrast, successful PC-producing countries such as Taiwan, Singapore and Ireland have integrated themselves into the global production networks led by multinational computer makers (Dedrick & Kraemer, 1998; Tallon & Kraemer, 2000).

By the early 1990s, a global production system was well established for computer hardware, with the United States, Japan and East Asia dominating the industry. Newcomers faced dim prospects for breaking in unless they had a unique asset, such as China's large potential market, to attract investment by multinational corporations (MNCs). But the industry has seen a shift toward build-to-order production in the late 1990s, requiring PC assemblers and some of their suppliers to locate production close to the final market. This trend has led to regional production strategies, with major PC makers having separate assembly plants in Asia, North America and Europe in order to serve the three major markets. The result has been new opportunities for countries such as Ireland, Scotland, Hungary and as we shall see, Mexico.

(b) *Economic environment*

Brazil and Mexico are the largest economies of Latin America, with Brazil's GNP about twice that of Mexico. The countries have similar levels of GNP per capita and industrialization. Brazil has managed to grow about twice as fast as Mexico since 1980, although it was plagued by high inflation until the mid-1990s.

While Mexico became more open during 1980–96, with trade increasing from 24% to 42% of GDP, Brazil actually became more

self-contained, with trade dropping from 20% to 15% of GDP (World Bank, 1999). Privatization of state enterprises in Brazil gained impetus from 1996 and in some sectors, such as telecommunications, has been completed. Both countries' mix of exports has shifted from primary products to manufactured goods, but much more dramatically in Mexico.

Both countries endured foreign debt crises during the 1980s, leading to severe economic downturns. In response to these crises and resulting pressure from international lending agencies, both countries began to open up their protected domestic markets. By the late 1990s, each had privatized state enterprises, opened major industry sectors to foreign investment, and lowered tariffs and other trade barriers. In addition to beginning earlier, in Mexico, the liberalization process was swifter and broader, while in Brazil it unfolded more gradually.

Both countries have joined the World Trade Organization and both have entered free trade agreements in the 1990s. Mexico joined the United States and Canada in NAFTA, while Brazil spearheaded the creation of the MERCOSUR (MERCOSUL in Portuguese) free trade area, which includes Argentina, Paraguay and Uruguay. For Brazil, MERCOSUR is significant, but the three other countries have a combined GNP of only US\$335 billion, or less than half that of Brazil. On the other hand, NAFTA gives Mexico access to the US and Canadian markets, with a combined GNP of US\$8.3 trillion (World Bank, 1999). This asymmetry, as well as its close proximity to the United States, make Mexico a logical place to locate high-volume manufacturing for the North American market, while production in Brazil is still mostly for the domestic or MERCOSUR markets.

The economic differences between Brazil and Mexico also help explain the different approaches taken to liberalization. Brazil, with its larger economy and distance from other major markets, has been more inclined to protect and promote local industries, while Mexico has been willing to open its market in return for the promise of access to the large North American market.

(c) *Political environment*

Brazilian politics have been in a period of relative stability since the early 1990s. The ongoing democratization, begun in the late 1970s, was further consolidated by economic

stability brought about by the end of inflation with the 1994 Real Plan. Even before then, the Brazilian State had begun reducing its economic role. The Brazilian Congress, dominated by a multiparty government alliance, has supported the government's strategies of liberalization and privatization, although it has resisted more profound changes in the critical areas of social security and public deficit control (Tigre & Botelho, 2001).

Mexico was governed by the Institutional Revolutionary Party (PRI) from 1929 until 2000, the longest continuing rule of any political party in the world. The PRI's hegemony finally ended with the election of opposition candidate Vicente Fox in 2000, but the conservative Fox is not expected to backtrack on the liberalization efforts of the past 15 years.

(d) *National capabilities*

The potential impacts of liberalization on a country are affected by a set of national capabilities needed for production and use of computers and information technology. Most important of these are the quality of the telecommunications infrastructure and human resources, and the size and competitiveness of the IT industry before liberalization. Telecommunications infrastructure is vital to effective use of IT, especially in the era when Internet and other network technologies are coming to dominate. Human resources include everything from literate workers for advanced manufacturing facilities to engineers and technicians needed by the IT industry, to scientists and researchers who can conduct research and development (R&D) and develop new technologies.

The capabilities of the existing IT industry can also affect the results of liberalization. If domestic companies are already internationally competitive, they are likely to survive and even thrive under liberalization. If they have succeeded only by taking advantage of the protected domestic market, they are unlikely to survive the onslaught of foreign competition. Even if existing companies do not survive, however, there may be individuals who have gained experience starting and managing companies, and these skills will still prove valuable after liberalization. They can shift to different industry sectors, start new companies or help foreign MNCs carry out higher value-added activities within the country.

Table 1. *Comparative telecommunications indicators, 1998^a*

	Main lines Per 1,000 inhabitants	Cellular mobile Subscribers per 1000 inhabitants
Mexico	104	35
Brazil	121	47
Korea	432	302
Taiwan	524	216
Malaysia	202	101

^a Source: ITU (2000).

The ability of a country to participate in a global, post-liberalization environment and realize the potential benefits of that participation depends to a great extent on whether it has or can develop all of these capabilities.

(e) *Telecommunications infrastructure*

The telecommunications infrastructures of Brazil and Mexico are quite similar in terms of wired and wireless penetration. As Table 1 shows, however, both countries lag significantly behind Asian countries such as Malaysia, Korea and Taiwan in terms of main lines and cellular phone subscribers per 1,000 people. Both Latin American countries have seen improvements, thanks to privatization and deregulation of the telecommunications sector in recent years, and further improvement is likely.

(f) *Human resources*

The general level of education in Mexico and Brazil is about average for their income levels. In terms of IT skills, both countries have high-quality personnel and quite large numbers of professionals, as Table 2 shows. Interviews with

managers of IT companies in both countries confirm the high quality of engineering skills for the hardware industry, and a good supply of software skills as well. These skills are available at a much lower cost than in industrialized countries, an additional attraction for IT companies.

(g) *IT industry*

Prior to liberalization, Brazil had a larger and more technologically advanced IT industry, which produced a wide range of systems, peripherals and even some components (Tigre, 1992). But, the industry produced mostly for the protected local market and had not honed itself against foreign competition. Mexico's IT industry, by contrast, was dominated by foreign MNCs even during the protectionist 1980s. Locally-owned companies had initially tried to develop their own PC designs and brands, but once the restrictions on component imports were loosened, they shifted to simple assembly of PCs based on foreign designs and components (Borja, 1992).

These differences help to explain Brazil's more active local entrepreneurs after liberalization. Both countries do have well-educated entrepreneurs who have entered the IT industry, but there is more activity in Brazil. This could be due to the larger role of foreign multinationals in the Mexican market, offering more job opportunities and also more competition to potential entrepreneurs. In addition, the larger Brazilian market offers more opportunities for startups to target niche markets at home, and Brazil's government has more actively supported local entrepreneurs through export assistance and incubator programs. But the fact that Brazil had a domestically-owned computer industry before

Table 2. *Human resource indicators*

Country	Mexico	Brazil	Korea	Taiwan	Malaysia
Population (millions) ^a	96.5	159	44.9	21	20.1
Adult literacy (%) ^a	90	83	98	na	84
Mean years of education ^b	4.7	3.9	8.8	NA	N/A
Secondary enrolment ratio (%) ^a	58	45	101	NA	57
Masters and Ph.Ds in science and engineering awarded, 1990 ^c	5916	N/A	7070	4011	N/A
R&D scientists and technicians per 1,000 people ^a	0.3	0.2	2.9	N/A	0.2
Number of software professionals ^d	321,482	549,840	340,168	140,070	53,389

^a UNDP (1998).^b UNDP (1993).^c Dedrick and Kraemer (1998). For Mexico, CONACyT (1995).^d Jones (1998).

liberalization meant that many professionals gained experience in financing, launching and managing their own companies, a set of skills developed by fewer Mexicans.

4. LIBERALIZATION OF THE COMPUTER SECTOR

(a) *Pre-liberalization policies*

During the 1980s, both Brazil and Mexico employed protectionist policies in order to promote their respective computer industries. The policies differed in scope, with Brazil's "market reserve" policy causing more consternation among trading partners, especially the United States. Brazil's policies placed a heavier emphasis on local ownership, while Mexico initially favored joint ventures and ultimately allowed full foreign ownership. Both countries accepted the *de facto* presence of IBM in the mainframe computer market, and targeted the emerging minicomputer and microcomputer (PC) markets for development.

In 1981, the Mexican government formulated the so-called Program to Promote the Manufacture of Electronic Computing Systems, Their Central Processing Units and Their Peripheral Equipment, more commonly referred to as the Computing Program. The key goals of the plan were to generate local production of microcomputers, peripherals and components, to promote exports, and to achieve greater autonomy in computer technologies (Borja, 1992).

As part of the program, access to the domestic computer market was limited to companies that would produce according to the Program's provisions, and foreign ownership was limited to 49% in the production of PCs and peripherals. Foreign companies were required to invest between 3% and 6% of gross sales in R&D, and include a minimum proportion of Mexican-made parts and components in their systems. Preferential treatment was given in government procurement to companies registered in the program.

Almost as soon as the policy was put in place, the environment began to change. First, the debt crisis of 1982 shifted the government's emphasis from industrial policy to financial policy, with the balance of payments becoming the critical concern. Second, the introduction of the IBM-PC led to standardization of the PC industry on the IBM architecture and the creation of a

global production network for high-volume PC production (Dedrick & Kraemer, 1998).

These two developments led to a shift in strategy in 1985 when IBM asked permission to produce PCs in Guadalajara, but balked at the joint venture requirement in the Computing Program. The Mexican government was opposed to granting an exemption since other foreign firms had already formed joint ventures with Mexican partners. But keeping IBM out of Mexico's PC market would isolate the country at a time that it hoped to become more integrated into the emerging industry (Dedrick *et al.*, 2001).

Ultimately, IBM and the Mexican government came to an agreement that gave IBM the right to retain full ownership of its new plant in return for concessions on R&D and development of local suppliers. Most important, IBM agreed to export a large share of the plant's output, helping Mexico reduce its trade deficit in PCs from \$200 million in 1985 to \$78 million in 1987 (Borja, 1992). After the IBM decision, the government shifted its emphasis from industry protection to encouraging IT use and eventually to liberalization.

Brazil's computer industry policies in the 1970s and 1980s followed a "greenhouse" strategy of protecting domestic producers to allow them to grow and innovate. The goal was to limit linkages between local and foreign firms, so that local companies could develop capabilities for autonomous innovation without depending on foreign technology (Evans, 1992). This policy, dubbed the market reserve, focused on the lower end of the market—first minicomputers, and then microcomputers as well. Foreign competitors were kept out of those segments of the Brazilian market through restrictions on imports and foreign investment. Local companies were prevented from acquiring foreign technology without government permission.

This policy gave local firms the space to grow and develop capabilities, and by the end of the 1980s, Brazil had a set of diversified IT companies with significant presence in the local market. The output of local computer hardware producers grew from less than \$200 million in 1979 to more than \$4 billion in 1990, and some local firms produced impressive results in R&D (Evans, 1992). But, the industry was largely isolated from the dynamism of the global PC industry, and Brazilian computer companies were not competitive outside the protected domestic market. Moreover, many local firms made no effort to innovate and

chose instead to pirate or surreptitiously license foreign technology while taking advantage of the market reserve.

The market reserve policy also raised the cost of computers to users, although, as Tigre (1992) points out, the price gap between Brazil and the United States dropped significantly in the late 1980s, so that Brazilian prices were more in line with prices in Europe and Latin America. Still, there was a delay in introduction of new technologies that ranged from one to several years.

(b) *Forces driving liberalization*

Brazil began to reduce the heavy role of the state in its economy in the early 1990s, in the wake of a decade of economic stagnation. In the computer industry, the market reserve was abandoned in 1992 and replaced by a more market-oriented policy. The shift was driven in part by fears that Brazil was being left behind technologically in computers and IT. In addition, pressure for change was brought to bear by the US government, which threatened Brazil with Super 301 trade sanctions for its market reserve policy. There was also concern over high levels of smuggling and gray market activity (Tigre & Botelho, 2001).

While these factors pushed Brazil toward liberalization, the government did not want to lose the capabilities developed by domestic companies under the market reserve. Moreover, it wanted foreign companies to do more than simply import products to serve the Brazilian market, especially, given the country's balance of payments problems. As a result, the new policies adopted in 1992 included incentives for companies to produce in Brazil, and ensuing programs provided support for local companies entering the industry.

Mexico's decision to liberalize the computer sector was driven as well by the pressures of globalization in the industry, but it was supported by a stronger ideological commitment on the part of Mexico's leaders. Presidents Miguel de la Madrid (1982–88) and Carlos Salinas (1988–94) were technocrats with a neoliberal bent. Salinas opened the computer industry to trade and foreign investment in 1990 without apparent reservations as to the fate of the small local computer industry. Since then, the prevailing belief, in the words of one federal government official, is that "the best policy is to have no policy" (Dedrick *et al.*, 2001).

Mexico's unilateral market opening in 1990 actually brought its trade and investment poli-

cies for the computer sector more in line with those of the United States and Canada and thus, minimized the changes needed when NAFTA was implemented. The continuing reticence to adopt any computer industry policies or incentives is influenced by concerns that such policies would be seen in the United States as attempts to pull jobs across the border to Mexico.

(c) *Nature of liberalization*

Liberalization of Mexico's computer sector took place in a sweeping one-time move when the Computing Program was abandoned in 1990. The only remaining barrier to the Mexican market was a 20% tariff on hardware, which fell to 12% by 1994, and was phased out by 1998 within NAFTA. In 1999, the Mexican government established the Sectoral Promotion Program for producers and nontrading companies in the electric-electronics sector to import components and machinery from outside the NAFTA region at lower taxes (Palacios, 2000).

Brazil likewise removed most barriers to its computer market in 1992, but left in place a complex mix of tariffs and national and local taxes, which could total over 30% of the cost of a computer. By maintaining these taxes, Brazil could offer exemptions as a means of promoting domestic production. The goal was to allow foreign companies into the market with the latest technologies and lower prices, but to give them an incentive to locate production in Brazil.

(d) *IT promotion policies*

There have been significant differences in the degree to which the two countries have promoted IT production and use after liberalization. Brazil has replaced industry protection with an active policy of industry promotion, while Mexico has taken a *laissez faire* approach.

Brazil's post-liberalization IT policies were defined in 1991 by Law 8248/91, aimed at establishing alternative mechanisms to preserve local manufacturing and R&D activities in the computer sector. The approach taken was to offer exemptions to various taxes if companies would commit to certain levels of local production, local content and R&D. There were no barriers to imports or foreign investment; however, computer makers that simply

imported products for sale had to forego the benefits provided under the law.

The policy consisted of four types of incentives. First, fiscal benefits consisted of a waiver on the industrialized goods tax resulting in a reduction of 15% in the final cost of production. Second, a discount of 50% on income tax for R&D expenditures was available to all industrial sectors. Third, in order to provide support for new capital investment, a discount of 1% of the income tax payable by companies investing in IT firms was available until 1997. Fourth, government procurement policy favored the acquisition of IT goods developed and produced in Brazil, as long as they had similar prices to imported equipment. By 1997, 248 firms had taken advantage of the program, including most major domestic and foreign computer makers. A program to promote the software industry, called Softex, was introduced in 1993. The program includes the formation of regional centers and incubators to stimulate cooperation among small software firms, the installation of marketing offices in foreign markets to support Brazilian firms' export efforts, and provision of incentives for training IT professionals within firms (Tigre & Botelho, 2001).

While *laissez faire* has been the trend in Mexico, there have been some scattered attempts at industry promotion in the 1990s. When Ernesto Zedillo became president in December 1994, he called for the development and exploitation of information technology as a national goal. This goal was given form in the Plan for the Development of Informatics (PDI), which targets: (i) promotion of IT use; (ii) human resource development; (iii) research and development; (iv) development of a local IT industry to exploit niche opportunities; (v) improvement of the telecommunications infrastructure; and (vi) creation of the necessary legal framework to support IT (e.g., intellectual property rights).

Despite its broad objectives, the PDI has had little impact, for two reasons. First, there are no funds set aside to pay for new projects, so funding must come from the relevant government agencies' already tight budgets. Second, there is little coordination among the institutions involved, and no pilot agency to ensure that policies are designed to complement each other.

The government also is encouraging development of a local supplier base to support the multinationals producing in Mexico. The organizations involved are the Mexican

Investment Board, the foreign investment office of the Ministry of Commerce and Industrial Promotion (SECOFI), and two development banks—Banco Nacional de Comercio Exterior (Bancomext) and Nacional Financiera (NAFIN). In addition, the national electronics, telecommunications and informatics industry chamber (CANIETI) has implemented a strategy to develop a local supply base for the computer and electronics industries. There is, however, little coordination of efforts, limited funding and no overarching strategy aimed at developing long-term capabilities (Dedrick *et al.*, 2001).

To summarize, both Mexico and Brazil pursued protectionist policies in the computer sector in the 1980s, but under internal and external pressure, both liberalized in the early 1990s. Mexico opened up more quickly and completely, taking a hands-off approach to trade and investment in the IT sector. Brazil maintained a set of tariffs and taxes, for which it could offer exemptions as a tool to promote local production and R&D. Both countries implemented policies to promote the IT industry, but Brazil's were more extensive and better funded. In both cases, policies were mostly developed *ad hoc*, with no guiding long-term goals or coordination mechanisms to link production, use and creation of national capabilities.

5. IMPACTS OF LIBERALIZATION

Given these differences in policy, one might expect large differences in impacts. Yet in some respects, the impacts of liberalization have been similar in the two countries: consumers have benefited from lower prices and greater choice in computer products; IT use has expanded throughout the economy; and many local computer makers have been driven out of business by foreign competition. There have been significant differences as well, partly due to differences in the liberalization process, but more importantly due to differences in environment such as location, domestic market size, existing national capabilities, and also to IT policies. To analyze these impacts, we look at the following: domestic computer market, computer production, trade, IT use, and employment.

(a) Computer market

The impacts of liberalization on the computer market in Mexico and Brazil were different

in the short-run, as Mexico saw somewhat faster growth in computer sales after the liberalization of 1990, while Brazil's market at first stayed rather flat after its 1991 liberalization (Figure 2). Later, however, Brazil's market began to take off, mainly due to the successful effort to control inflation through the Real Plan in 1994. Once prices were stabilized, businesses could make more realistic long-term investment decisions and began to invest heavily in information technology. It was only then that the impacts of liberalization were fully felt. The market declined in 1999 due to a financial crunch and devaluation that were triggered by the Asian financial crisis.

In Mexico, the rapid expansion of IT spending was interrupted by the peso crisis and deep recession of 1995. Growth resumed, however, in 1996 and by 1997, the market had

surpassed its pre-crisis level and continued to grow solidly in 1998 and 1999.

In retrospect, there is evidence that liberalization accelerated the rate of IT spending in each country, although not as dramatically as might have been expected. This could be due to the fact that both countries had actually taken steps to push prices downward on domestically-produced computers even before liberalization by allowing imports of many components at lower tariff rates. Thus, IT spending was already growing in the late 1980s.

(b) Computer production

Computer production in Brazil first dropped in response to liberalization, which brought in imported computer hardware to compete with local production (Figure 3). After a one-time

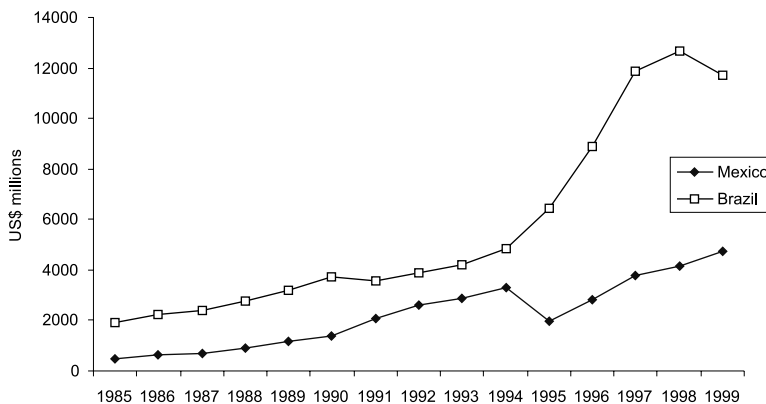


Figure 2. IT markets for Brazil and Mexico 1985-99. Source: IDC, data provided to authors.

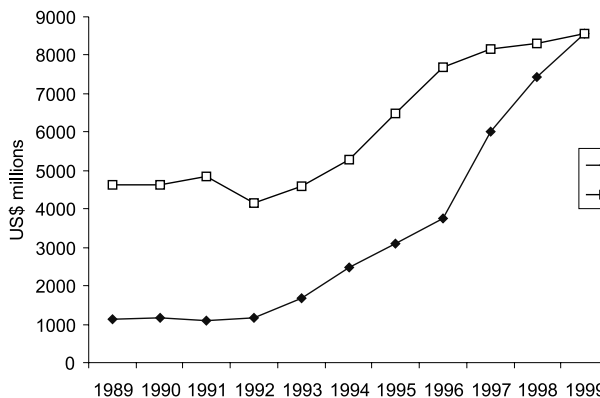


Figure 3. Computer hardware production in Brazil and Mexico, 1989-99. Source: Reed (various years).

drop in 1992, production began to grow as MNCs took advantage of Brazil's industry promotion policies by producing in Brazil for the local market.

In Mexico, liberalization initially had little impact on production. But, when the NAFTA agreements were signed in 1992, production began to grow steeply as new companies moved into Mexico and existing foreign producers increased production there in anticipation of NAFTA. The combination of low labor costs, NAFTA membership, and close proximity to the large US market made Mexico an attractive location for assembly of PCs and components such as printed circuit boards. By 1999, Mexico had actually equaled Brazil's total output for computer hardware, after trailing by a 4:1 margin in 1991.

Production in Mexico has continued to expand, recently with the influx of contract manufacturers (CMs) into the western state of Jalisco. Some of the world's largest CMs have come to Guadalajara and its metropolitan region. These include SCI, Solectron, NatSteel, Flextronics, Jabil Circuit and Dovatron, which joined brand name vendors IBM, Hewlett-Packard, NEC and Lucent, who were already operating in the area. IBM also has continued to increase its production of PCs, disk drive components, and software in its large Guadalajara facility, which employs around 10,000 people. This concentration of electronics production has led Guadalajara to be dubbed, the Mexican Silicon Valley, although a more accurate comparison would be with manufacturing clusters such as Singapore or Penang, Malaysia (Palacios, 1995; Dedrick *et al.*, 2001).

A similar, but smaller electronics hub is found in the state of Campiñas, Brazil, near Sao Paulo. Campiñas is home to computer manufacturers such as Compaq and IBM, as well as a growing number of contract manufacturers. These companies use Brazil as a production base for both the domestic market and the MERCOSUR free trade area (Botelho *et al.*, 1999).

(c) Trade

The differences between Brazil and Mexico in the post-liberalization era are most vivid in the area of foreign trade (Figure 4). Brazil has seen a steady increase in imports after opening its market, but exports have languished and a significant trade gap has opened. Mexico initially saw imports rise quickly, leading to a trade deficit in computers, but after the peso devaluation of December 1994, that deficit has turned into a surplus. The shift was due to a decline in imports, while exports continued to grow as they had ever since NAFTA was signed in 1992. In 1997–98, export growth accelerated even further as production by the newly arrived contract manufacturers came on line.

The difference between the two countries is that while both have seen substantial growth in computer production, in Brazil it was mostly for the domestic market, while in Mexico it was mostly for export. The reasons have to do with trends in the computer industry, geography and NAFTA, more than with liberalization of the computer sector *per se*.

In recent years, the PC industry has become extremely time sensitive, thanks to the rapid

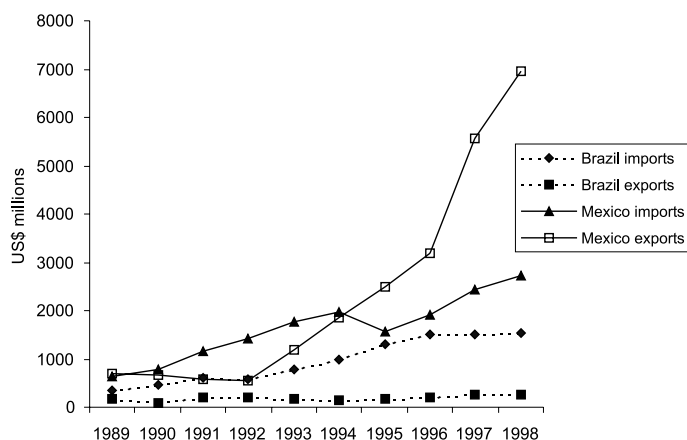


Figure 4. Trade in computer hardware for Brazil and Mexico, 1989–99. Source: Reed (various years).

depreciation of products and the build-to-order production model pioneered by Dell Computer (Curry & Kenney, 1999; Kraemer, Dedrick, & Yamashiro, 2000). This has pushed PC makers to locate production close to the market. For the US market, this often means producing in North America, and for labor-intensive activities such as assembly of circuit boards, cables, connectors and monitors, Mexico is an ideal location due to low wages and proximity to the United States. NAFTA's provisions helped further by creating greater confidence among foreign multinationals that Mexico's market liberalization was firmly rooted. The result has been a shift of contract manufacturing in particular from Asia to Mexico (Goad, 1999).

While most of Mexico's production is exported, most of Brazil's production is for the local market. The other MERCOSUL markets are so small that they provide limited export opportunities. Compaq is now using Brazil to supply all of South America, but the whole continental computer market, including Brazil, is less than one-tenth the size of the US market. Brazil cannot easily export to the United States because its industry centers are too far from the United States to ship time-sensitive products by truck or sea. Once air shipment is required, Brazil has no advantage over Mexico and large Asian producers such as Taiwan, Malaysia, China and Singapore in serving the US market.

(d) *Industry structure*

Since liberalization, both countries' IT industries have become increasingly dominated by foreign (mainly US) firms. There is a significant difference between the two countries,

as Brazilian-owned firms have sustained a larger share of their local market than have their Mexican counterparts. Table 3 shows that six Brazilian-branded PC companies controlled 25.6% of the market in 1997, while three Mexican-owned firms controlled only 12.2% of the market in 1998. Moreover, "white box" clones made by local assemblers accounted for over half of Brazil's market, compared to 21% in Mexico. The situation in Brazil may change in the future as PC heavyweights such as Dell and Gateway enter the market, but for the first decade of liberalization, Brazilian companies were better able to survive in the competitive PC market.

Beyond the PC industry, most Brazilian-owned hardware makers who had been producing minicomputers and peripherals either disappeared after liberalization, moved into other markets such as services and distribution or were bought out by foreign firms entering the Brazilian market. In the components market, Brazil has lost much of its production capacity as companies such as Itaútec have abandoned the components business and scaled back R&D in the face of international competition. Brazilian firms have, however, been able to sustain a larger role in niche segments of the IT industry, especially in banking automation, where Brazil had been an early adopter as banks responded to the demands of a high-inflation environment (Tigre & Botelho, 2001).

Few Mexican-owned firms have entered the components market, although a small Guadalajara firm, Compuworld has become a supplier of disk drive components to IBM. Otherwise, computer makers and contract

Table 3. *PC market share for Brazil and Mexico^a*

Brazil, 1997		Mexico, 1998	
Company	Market share (in %)	Company	Market share (in %)
Compaq (US)	10.4	Compaq (US)	20.0
Itaútec (Brazil)	6.8	Acer (Taiwan)	11.3
IBM Brasil (US)	5.6	IBM (US)	12.8
UIS (Brazil)	4.9	HP (US)	10.2
Tropcom (Brazil)	4.7	Alaska (Mexico)	8.9
Byte On (Brazil)	3.4	Dell (US)	3.8
Hewlett-Packard (US)	3.1	Lanix (Mexico)	2.9
Microtec (Brazil)	2.9	Toshiba (Japan)	2.9
Fivestar (Brazil)	2.9	Apple (US)	2.3
Acer (Taiwan)	2.5	Printaform (Mexico)	0.4
		Other int'l brands	2.8
Others (mostly white boxes)	52.8	White boxes	21.3

^a Source: Brazil, IDC cited in Crespo (1998). Mexico, IDC provided to authors.

manufacturers mostly import components under either the maquiladora or PITEX (Program of Temporal Importation for Export) regimes that allow for duty free import as long as the final products are exported (within up to 60 days).

On the other hand, local Mexican firms have been more successful in custom programming and information services, led by Softek, based in Monterrey, which had over 2,000 employees and over US\$50 million in sales in 1997. Some of the leaders in this segment have been taken over by US giants such as IBM (which bought software developer TecnoSys) and GE Capital (which bought 80% of system integrator EDM).

(e) *IT use*

Falling prices and a wider array of available products and services helped expand IT use throughout both countries' economies. As of 1998, Brazil was slightly ahead of Mexico in terms of PCs per capita, and both were well ahead of poorer developing countries such as China and India. But, compared to wealthier Asian economies such as Korea and Taiwan, Brazil and Mexico still lagged with less than one-third the number of PCs per 100 inhabitants (Table 4). Brazil compares favorably to other developing countries in total IT spending as a percentage of GDP, while Mexico is about average.

IT use in both countries has been spurred as well by increased competition across large segments of the economy. As foreign banks, retailers and manufacturers have entered previously closed markets, they have brought in advanced information systems and exposed Brazilian and Mexican managers to those technologies. Domestic companies have either looked for foreign partners to gain access to

such systems or have worked with foreign and domestic IT companies to develop their own capabilities.

After a slow start, the Internet has caught on in both countries in recent years. One reason has been the availability of lower cost PCs to access the Internet. Another has been the liberalization of telecommunications in each country, leading to lower prices and improvements in infrastructure. The growth in number of Internet users has supported an increase in Spanish and Portuguese language content, which has in turn drawn more users.

(f) *Summary and analysis*

In summary, liberalization has led to lower prices and greater diffusion of computer technologies in both countries. It also has created a better environment for foreign investment, which has brought with it leading edge technology and knowledge of how to use the technology more effectively. On the other hand, while both countries have seen growth in computer production, the growth has been much faster in Mexico. While Brazil's industry produces almost exclusively for the domestic market, Mexico has become a major export platform for the North American market.

Returning to the conceptual framework developed earlier in this paper, a comparison of Brazil and Mexico shows that differences in the impacts of liberalization in the two countries can be related back to the twin factors of environment and policy.

(g) *Impact of environmental factors*

—*Ideology and political dynamics.* In Mexico, powerful Presidents with a strong neoliberal ideology have implemented more rapid,

Table 4. *IT use indicators^a*

Country	PCs (millions) 1998	PCs/100 inhabitants 1998	IT spending as % of GDP ('98)	Internet users/ 1,000 people, 1998	Hosts per 1,000 people, 2000
Brazil	5	3.0	1.6	15	3
Mexico	4.5	4.7	1.1	14	4
USA	124	45.6	4.2	220	193
Japan	30	23.8	2.3	132	20
China	11.2	0.9	1.0	2	0.05
India	2.7	0.3	0.5	1	0.02
Malaysia	1.3	6.2	1.7	36	3
Korea	7.2	15.7	1.5	66	6
Taiwan	3.3	15.9	1.1	142	28

^a Source: ITU (2000) (PCs and Internet users); IDC (IT spending); Internet Software Consortium (2000) (hosts).

wide ranging liberalization programs with little effort to protect the domestic computer industry from foreign competition. Brazil's more pluralistic government has taken a more gradual approach to liberalization, maintaining some protection and incentives for local industry. This is also because the computer industry in Brazil has greater political influence due to the involvement of large banks, industry groups, universities and the military. By contrast, Mexico's domestic computer companies are mostly small independent startups with little political clout.

—*International political environment.* Pressure from foreign governments has had an impact on liberalization and IT policy for both countries. Brazil faced strong US opposition to its market reserve policies and decided to liberalize at least partly in response to that pressure. Mexico liberalized unilaterally in advance of negotiations to join the GATT and later to join NAFTA. Mexico also has been limited in its ability to offer investment incentives that other countries commonly provide due to two factors: (i) concerns that Mexico can be seen as trying to lure jobs south of the border, especially since NAFTA has been in effect; and (ii) congruence with the Salinas and Zedillo administrations' decided advocacy of free market ideology which required the government to follow a hands-off policy orientation. As a result, Mexico was passed over by Intel when it decided to locate an assembly plant in Costa Rica instead of Guadalajara, given the incentives the company was offered by the Costa Rican government.

—*Size and location.* Brazil's larger domestic market and distance from major IT markets have encouraged a greater focus on production for the local market. It has also supported more local entrepreneurship in market segments such as banking automation, software and Internet services and content. On the other hand, Brazil has run up a large trade deficit in IT as its imports have grown, but it has failed to grow exports. By contrast, Mexico's proximity to the United States and membership in NAFTA have made it more of an export platform for multinationals. It also has been easier to serve the Mexican market with products from the United States, so local entrepreneurs have had more limited opportunities and less incentives to enter the PC making business.

—*Industry trends.* The PC industry's trend toward increased inventory turnover and build-to-order production has favored Mexico as a production location for North America, and has attracted production to Brazil for South America. While Mexico clearly benefits more due to the size of the North American market, Brazil should enjoy increased production as the South American market, particularly within MERCOSUR, grows.

(h) *Impacts of policy*

—*Pre-liberalization policy differences.* Brazil's market reserve policies put greater emphasis on promoting local ownership and domestic content than Mexico's Computing Program, so by the time of liberalization, there were a number of vertically-integrated computer firms in Brazil making a range of systems and components. Some of these firms survived in certain segments of the systems market (such as PCs), while others shifted to software and services. By contrast, Mexico failed to develop strong locally-owned computer makers, or even suppliers to MNCs, during the 1980s. After liberalization, foreign companies grabbed market share in sectors that had been closed to them previously. On the other hand, Mexico's maquiladora program had helped attract foreign investment in electronics assembly, helping it to develop skills and experience that attracted computer makers and contract manufacturers.

—*Differences in the pace of liberalization and remaining internal barriers.* The continuing presence of various taxes, slow customs processing and other costs (referred to as the "Brazil cost") in Brazil discouraged many foreign firms from entering the market until recently. These costs also make Brazil less competitive as a producer for global markets. On the other hand, domestic companies have been given time to adjust, often by switching from hardware production to other industry segments. By contrast, Mexico's liberalization was more sudden and comprehensive, and foreign companies quickly flooded into the Mexican market. This competition has driven local companies out of the market and possibly discouraged local entrepreneurs from entering the IT industry.

—*Differences in complementary IT policies.* IT policies have had an impact, but less so

than environmental factors. Brazil's various tax incentives have helped increase local production by foreign MNCs selling to Brazil and MERCOSUR, and have begun to attract contract manufacturers. Perhaps more important have been programs to promote the software industry and develop Internet infrastructure. These efforts go beyond promotion of commodity hardware production and move Brazil toward the most dynamic segments of the IT industry. Mexico, by contrast, has done little to provide government support to promote the development of software and Internet services, sectors with a large potential market of Spanish speakers in Latin America and the United States. It also has failed to offer incentives to compete with other countries for foreign investment. Industry executives have stated in interviews with the authors that Mexico could attract much more investment in components production if it offered incentives comparable to those of Asian and European countries.

—*Development of capabilities.* Both countries have made important gains in quality of telecommunications infrastructure as a result of privatization, deregulation and introducing competition into the sector. Brazil has done more to help entrepreneurs gain the knowledge and resources they need through programs such as Softex. Mexico has done little to develop such resources to support local entrepreneurs. It has, however, done a good job of meeting the human resource needs of the growing IT industry in places such as Guadalajara, mainly through the efforts of local government and educational institutions.

6. CONCLUSIONS AND IMPLICATIONS

While a comparison of two countries is not sufficient to draw broad conclusions, the cases of Mexico and Brazil do provide insights into the five questions raised earlier in this paper. Based on those questions, we draw the following conclusions:

—The idea of promoting a domestic computer industry behind protective barriers was not tenable in an industry marked by rapid technological change and dominated by multinational companies who set and control global technology standards. We would argue that liberalization was a necessary and

perhaps inevitable process for both Brazil and Mexico, given the globalizing trends in the computer industry in the early 1990s. Prior to liberalization, IT users in Brazil and Mexico were paying relatively high prices for computers, and local computer makers were not competitive outside their protected domestic market. India's similar efforts to develop a domestic computer industry behind protective barriers was even less successful, and Korea's ban on PC imports in the 1980s isolated it from global markets (Dedrick & Kraemer, 1998). For Brazil and Mexico, the question was no longer whether to liberalize, but rather when and how to do so.

—Liberalization has had mixed results in both countries. It has been beneficial in terms of reducing the cost of computers and expanding diffusion of IT throughout the economy. Both countries also have seen growth in production and have attracted investment from leading multinational computer makers. On the other hand, there have been tradeoffs, particularly, the demise of domestic firms in the face of foreign competition, and in Brazil's case, an expanding trade deficit in computers. So while liberalization has lived up to many of the promises of its advocates, it also has led to painful dislocations as feared by skeptics.

—National environments do make a difference. Brazil and Mexico took somewhat different approaches to liberalization, and these variations did affect outcomes, but ultimately it was differences in size and geographic location that had a bigger impact. Mexico's proximity and close economic ties to the United States were enhanced by liberalization, and resulted in its becoming an export platform for the US market. Brazil's larger domestic market and its distance from major world markets led to the creation of an industry oriented to serving local and regional demand, with little export production.

—Government can play a positive role beyond simply liberalizing and taking a hands-off approach to the industry. Policies that promote IT production and use can succeed if they take into account both global market forces and national environment. It is possible to learn from the experiences of others, but those lessons must be applied with a clear understanding of local market conditions, national capabilities and changing global forces. What worked for Mexico

will not necessarily work for other countries located far from major markets, and what worked for Brazil will not work for countries with very small domestic markets.

—A comprehensive policy approach to the computer sector needs to go beyond the debate over whether to liberalize, as that process is already far advanced in most developing countries. Liberalization is now seen as a first step to ensure that countries have access to international markets, technology and foreign capital. Beyond that, the issue is how to realize the potential benefits from increased competition at home and from participation in global markets and global production networks. What has been made clear by the mixed experiences of Brazil and Mexico, and the success of countries such as Taiwan, Singapore and Ireland, is that countries need to focus on developing

national capabilities such as human resources, high-quality and low-cost telecommunications networks and Internet connections, as well as financial systems capable of supporting local entrepreneurs (see Dedrick & Kraemer, 1998; Tallon & Kraemer, 2000). By doing so, a country can take advantage of opportunities in the global market while developing national applications of information technology. These countries also show the value of having a coordinated policy approach that explicitly links computer production, use, and the creation of capabilities, supported by a clear understanding of global market and technology factors. Such a coordinated approach can help a country adjust to the dislocations caused by liberalization, and to take advantage of the opportunities created.

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